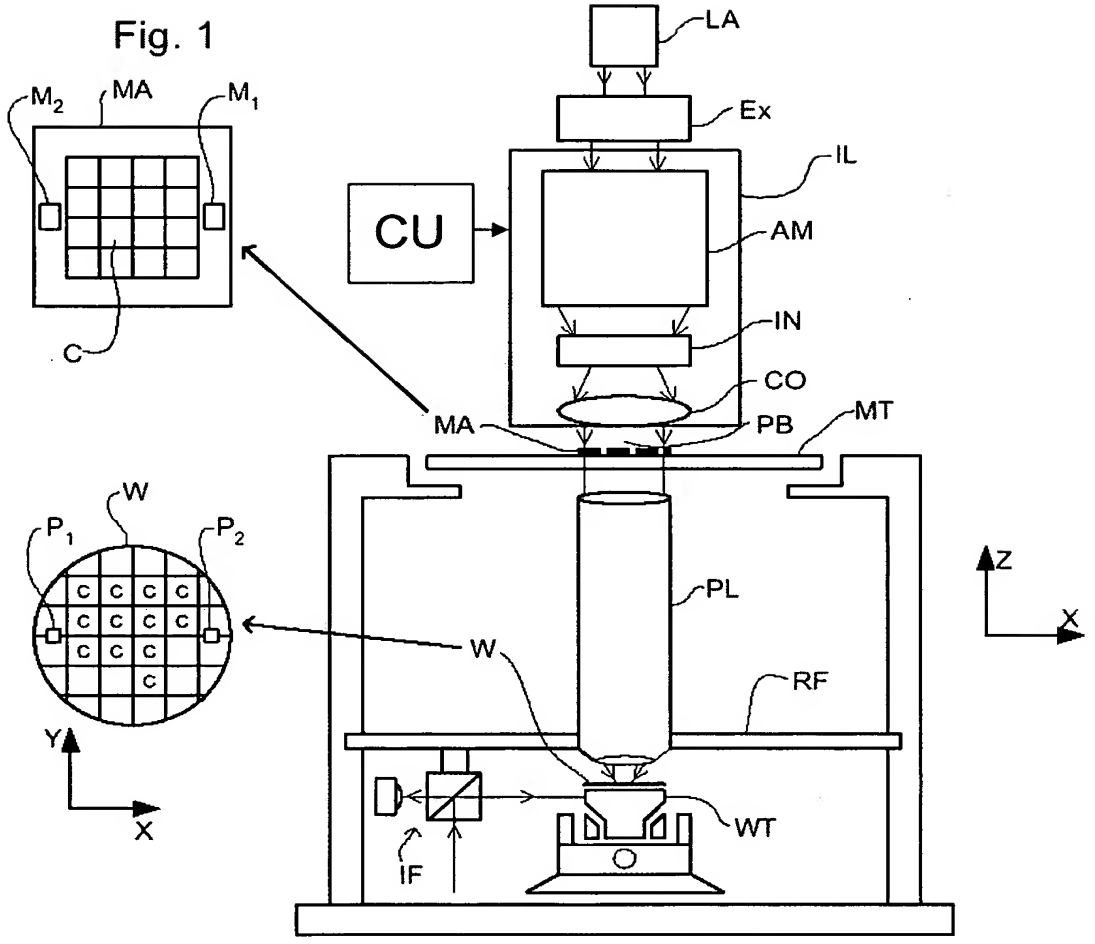
Fig. 1



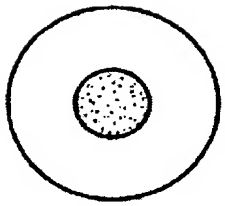


FIG. 2

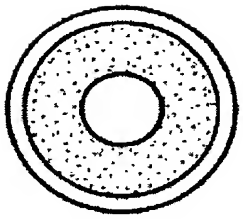


FIG. 3

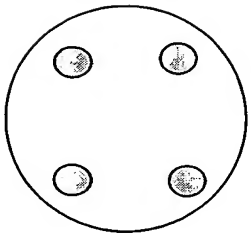


FIG. 4

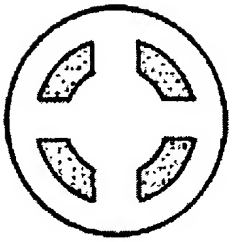


FIG. 5

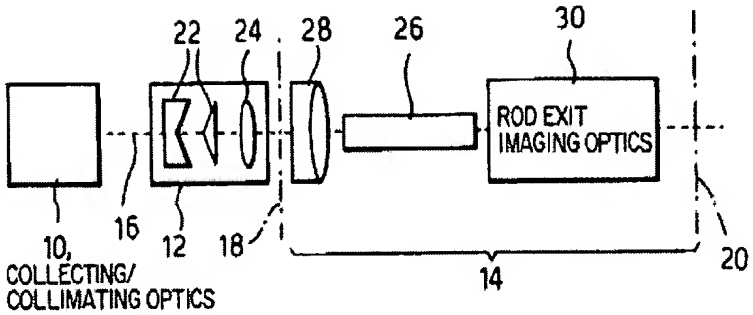


FIG. 6

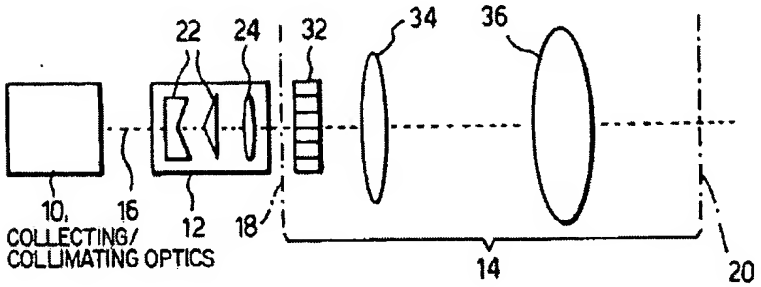


FIG. 7

FIG. 8

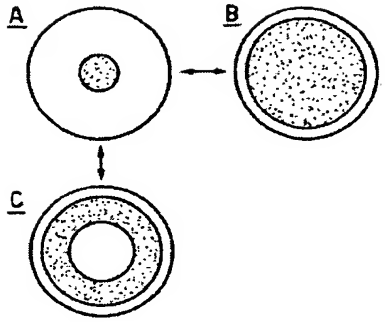
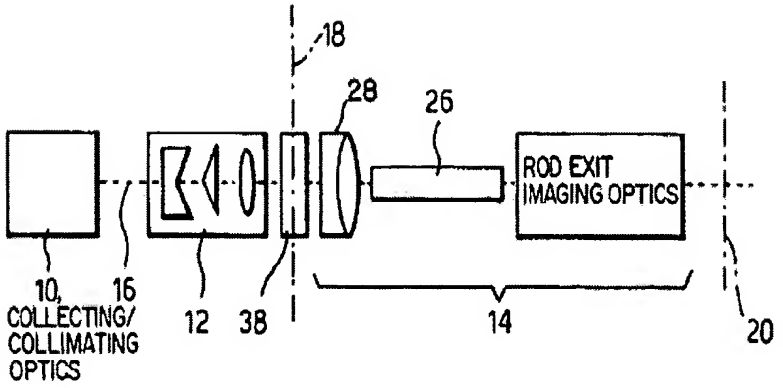

A
B
C

FIG. 9


18
28
26
ROD EXIT
IMAGING OPTICS
10,
COLLECTING/
COLLIMATING
OPTICS
16
12
38
14
20

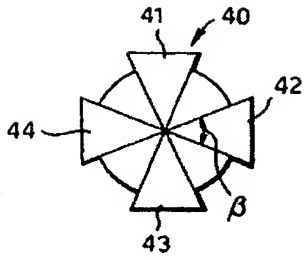


FIG. 10a

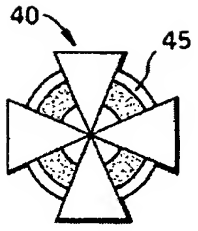


FIG. 10b

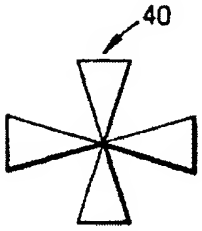


FIG. 11

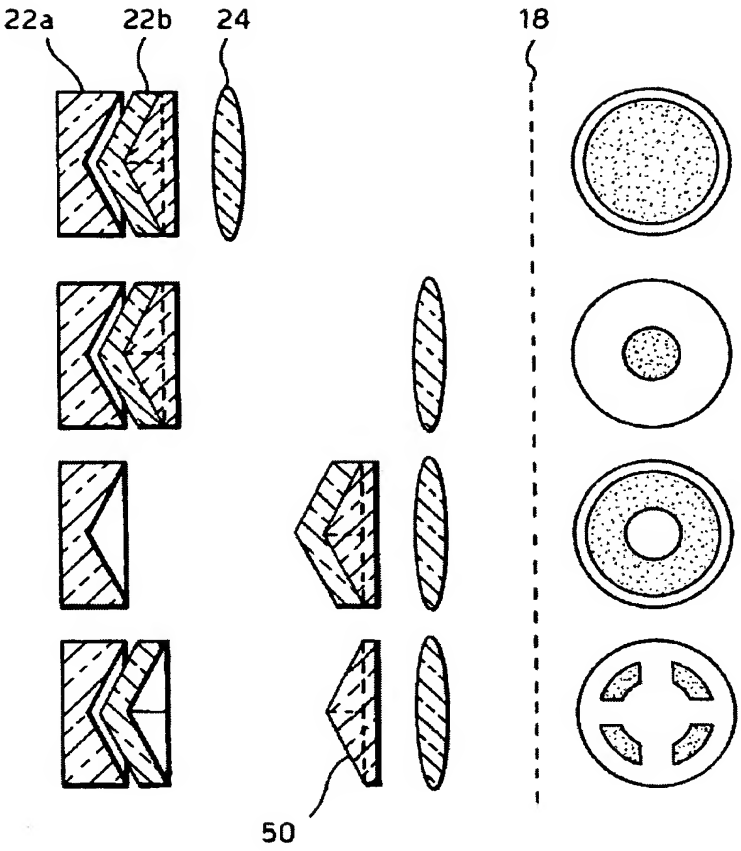


FIG. 12

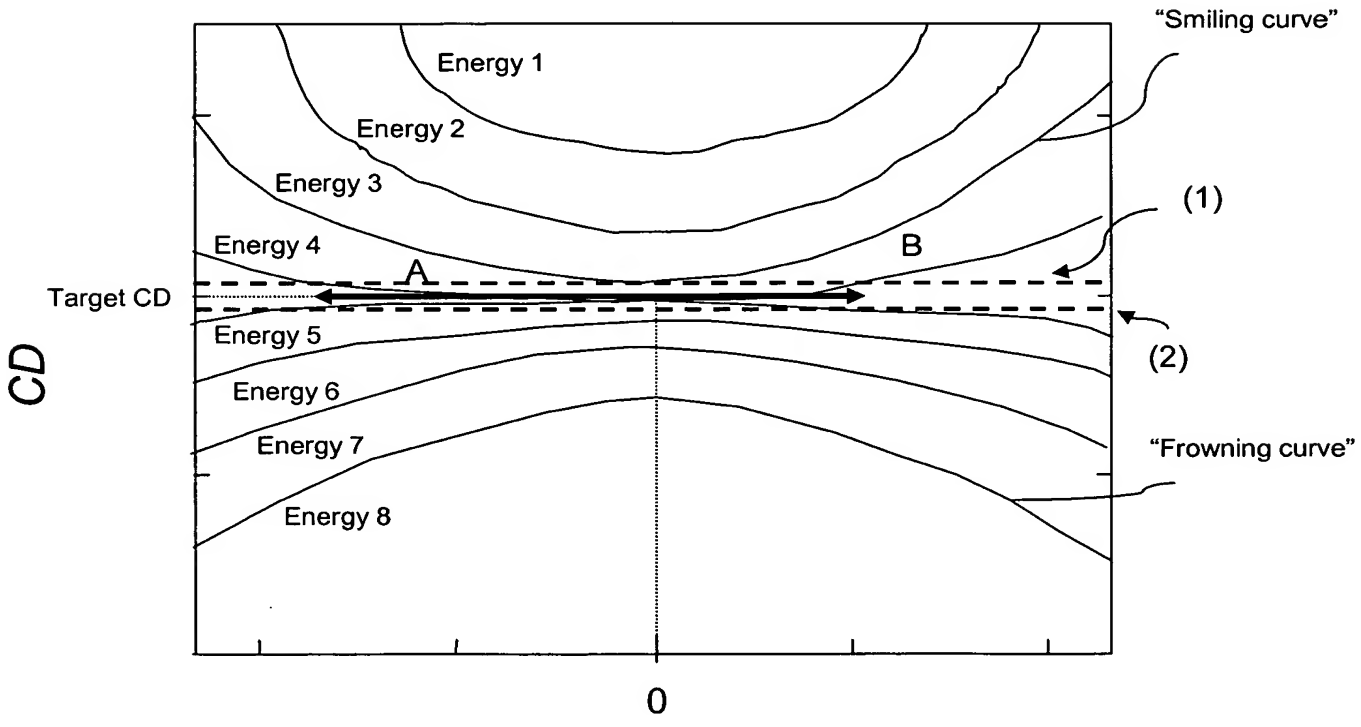

"Smiling curve"
Energy 1
Energy 2
Energy 3
(1)
Energy 4
B
A
Target CD
Energy 5
(2)
Energy 6
Energy 7
"Frowning curve"
Energy 8
CD
0
Focus

FIG. 13

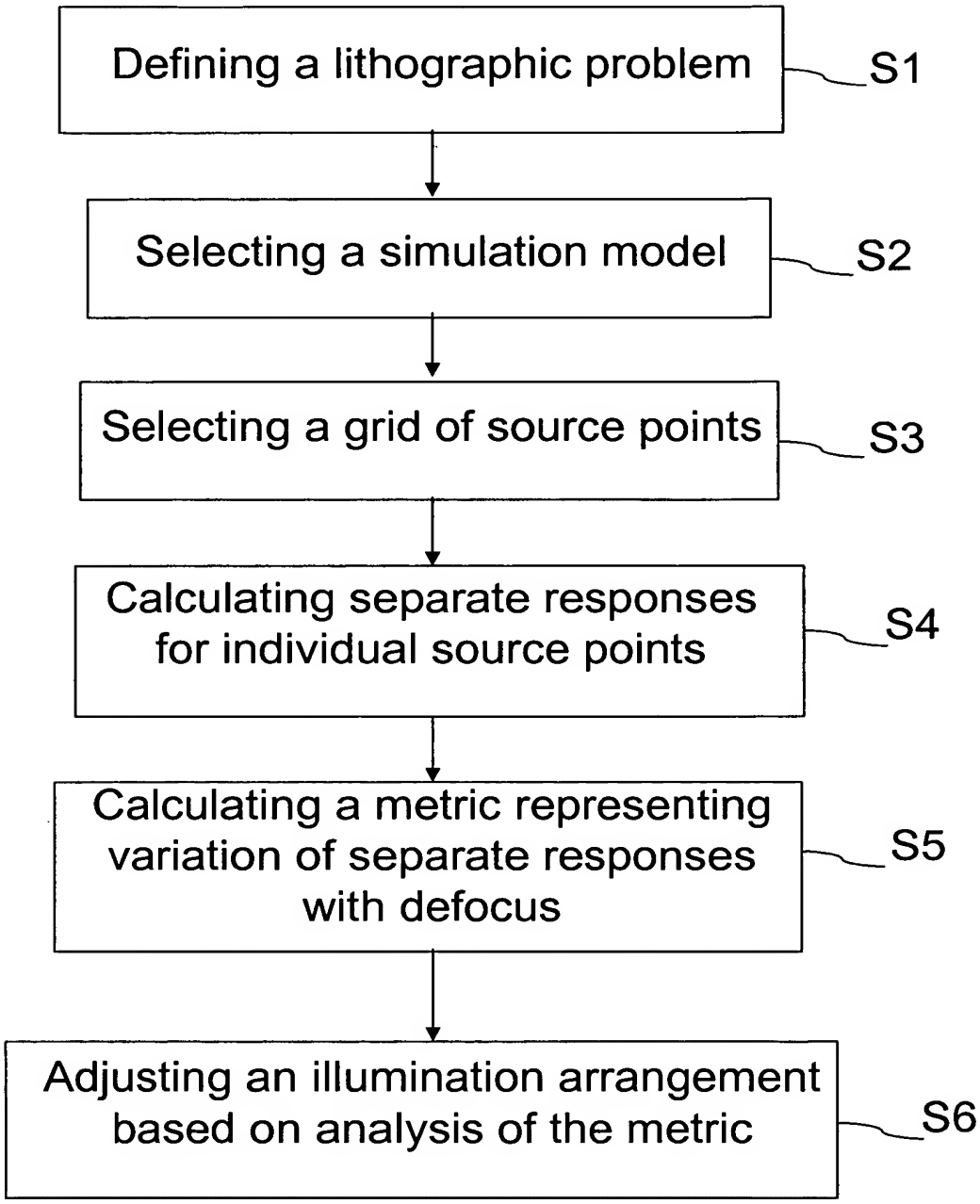

Defining a lithographic problem
S1
Selecting a simulation model
S2
Selecting a grid of source points
S3
Calculating separate responses for individual source points
S4
Calculating a metric representing variation of separate responses with defocus
S5
Adjusting an illumination arrangement based on analysis of the metric
S6

FIG. 14

FIG. 15a

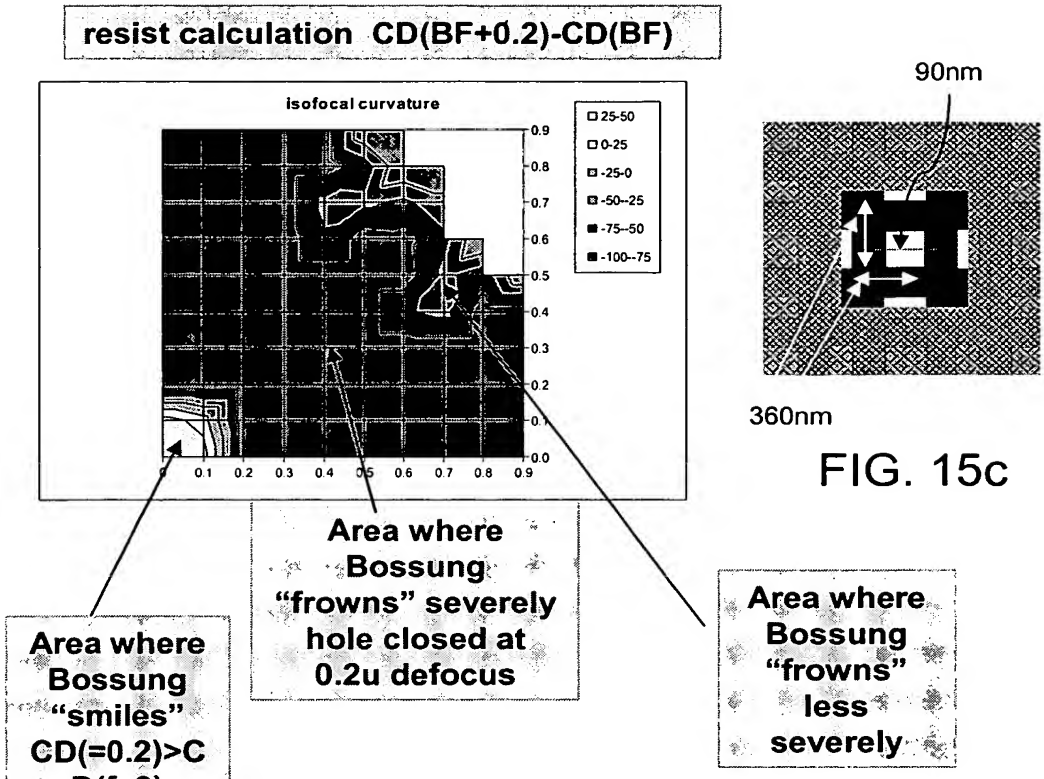
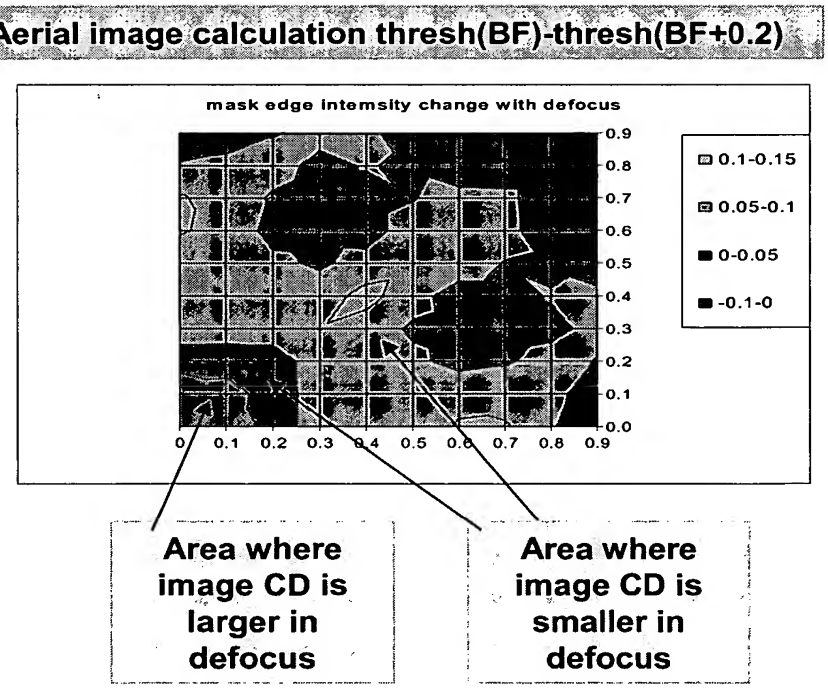


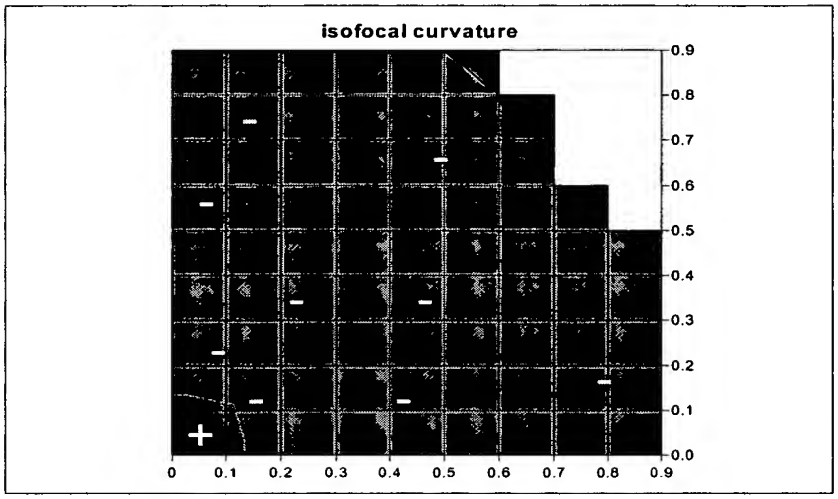
FIG. 15c

FIG. 15b



resist calculation CD(BF+0.2)-CD(BF)

FIG. 16a



Aerial image calculation thresh(BF)-thresh(BF+0.2)

FIG. 16b

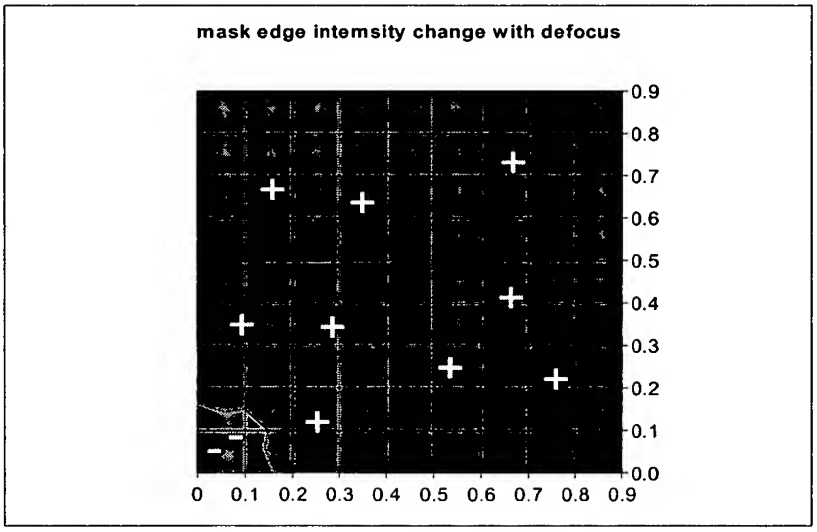
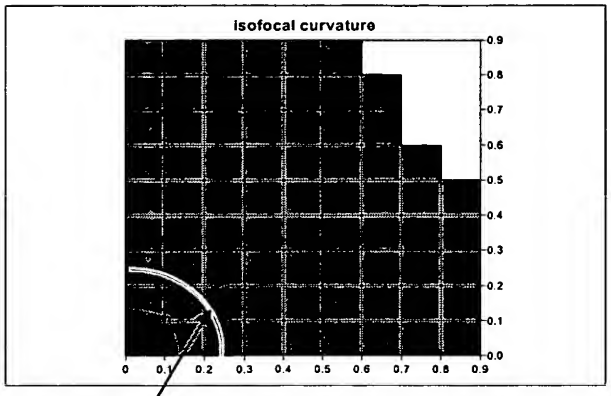


FIG. 17



σ=0.25 combines areas of + and - isofocal curvature

At σ=0.25, process is approximately isofocal. DOF is good but dose latitude is low.

FIG. 18

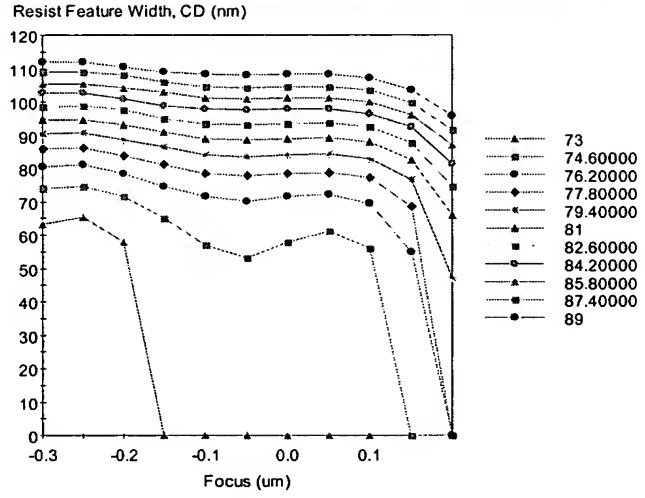
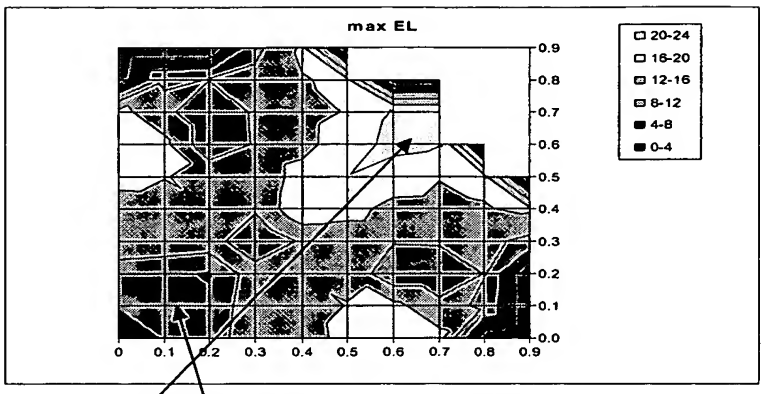


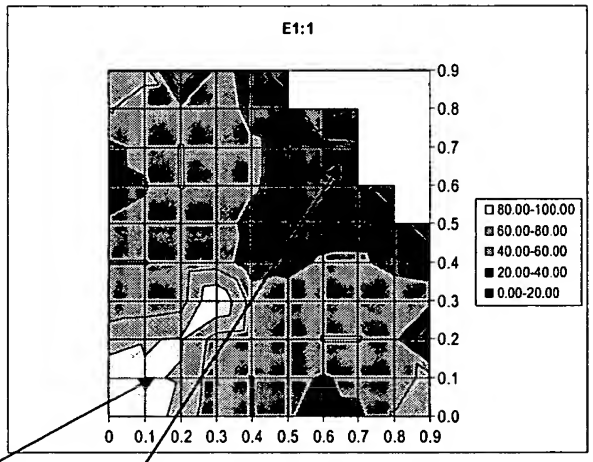
FIG. 19a



Low σ area provides poor EL and also requires high dose to print (weak aerial image)

Desirable area for high EL is wide quasar

FIG. 19b



Low σ area provides poor EL and also requires high dose to print (weak aerial image)

Wide quasar also provides low E1:1 (strong aerial image)

FIG. 20

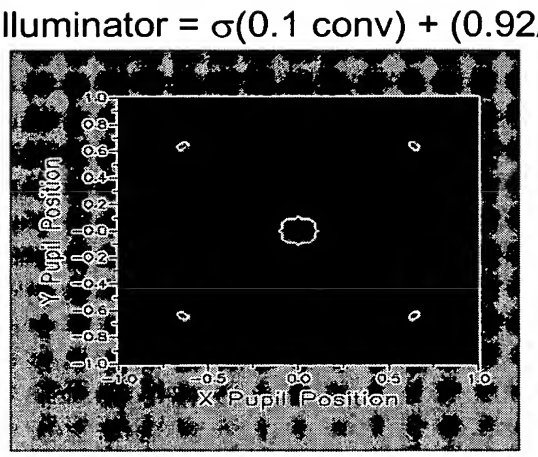


FIG. 21

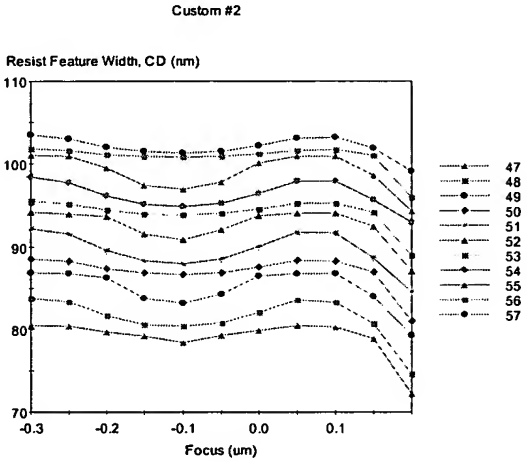
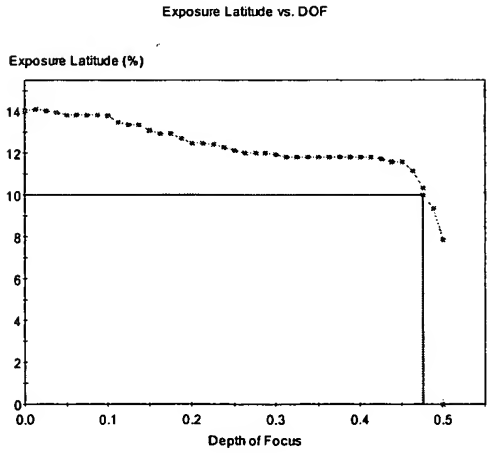


FIG. 22



optimization method	illumination	max EL	max DOF	DOF @ 10% EL	DOF @ 5% EL
standard	0.95/0.70Q30°	18%	0.3	0.18	0.24
simple isofocal compensation	0.25 conv	8%	>0.55	0	0.29
high EL isofocal compensation	0.92/0.88Q5°+0.1conv	16%	>0.65	0.57	0.63

FIG. 23

Large improvement in process window may be possible by appropriate use of illuminator to compensate isofocal curvature

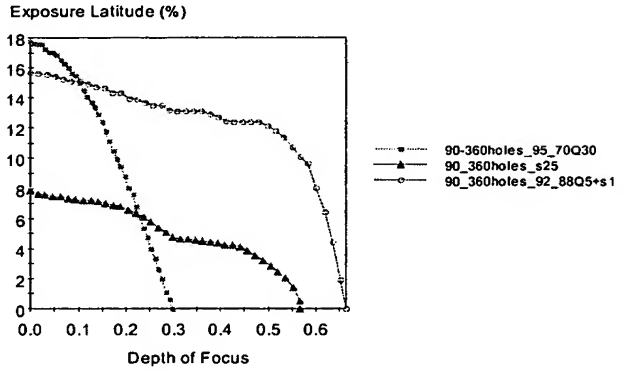


FIG. 24a

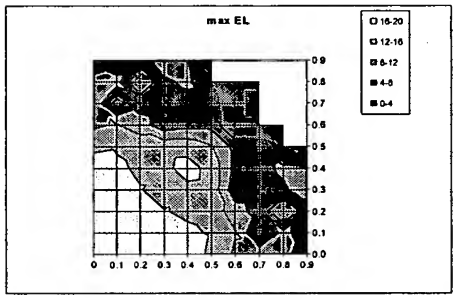


FIG. 24b

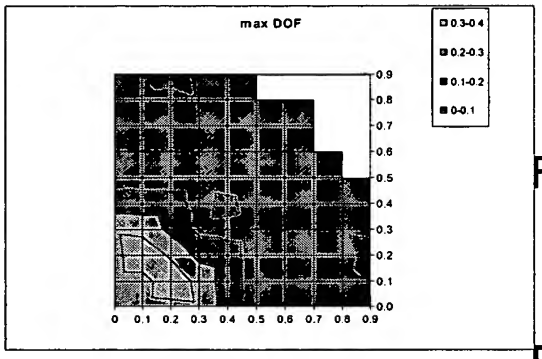
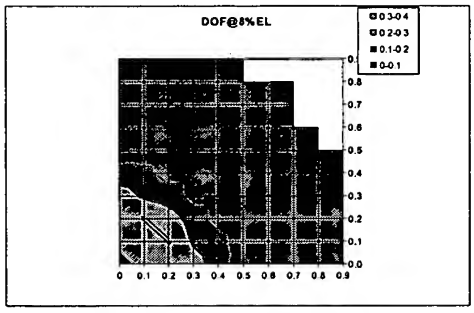


FIG. 24d

FIG. 24c



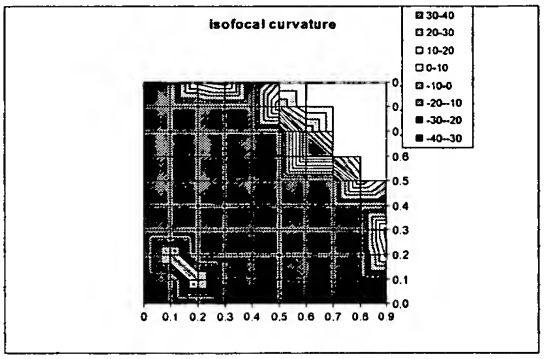


FIG. 25a

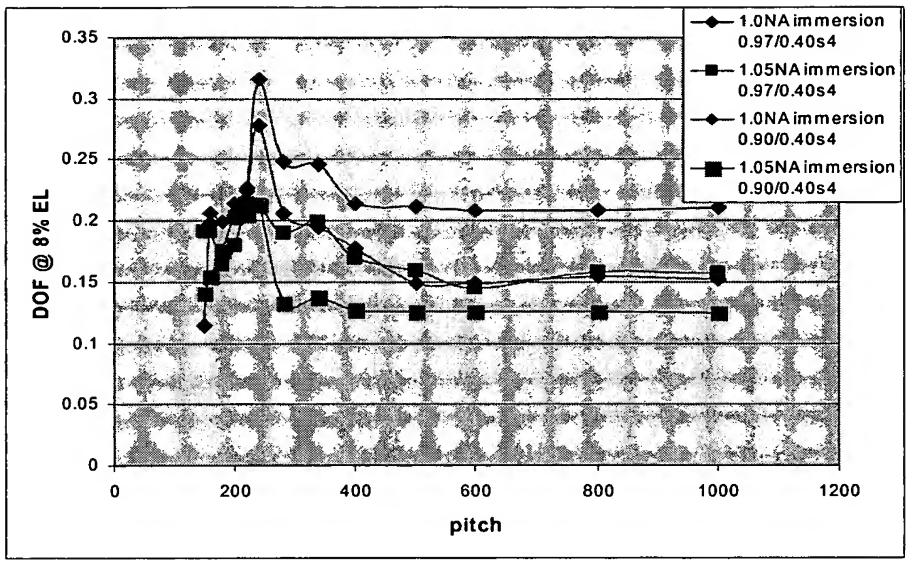
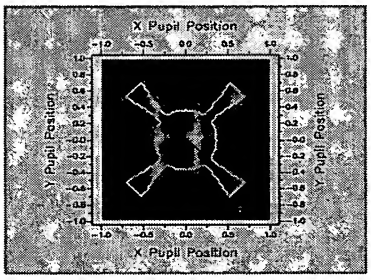


FIG. 25b

0.90/0.40+0.4σ



0.97/0.40+0.4σ

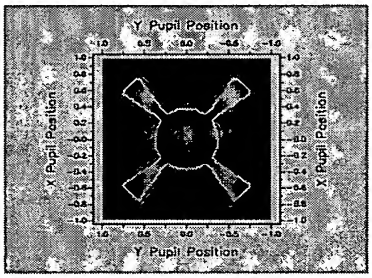


FIG. 25c